

Application Serial No. 09/478,849
Amendment Dated 26 September 2005
Response to Office Action mailed on 26 May 2005

Docket No. CIC-037-US

In the Specification:

Please replace the two consecutive paragraphs beginning on column/page 6, line 37 with the following:

A third principle by which the present invention operates also explains in part why the aforementioned ray bundle reversal is not deleterious in the case when the convergent mirror is placed proximate the intermediate image. Consider again a single axisymmetric positive lens imaging an object to form an intermediate image. In this case however, further consider that the lens is designed to correct all forms of aberrations such that only field curvature and distortion exist. Such an intermediate image will therefore be in sharp focus only over an intermediate image surface conforming to the field curvature of that image. In other words, if a light-scattering screen were placed exactly at the intermediate image with a curvature identical to the field curvature of the positive lens, then the image formed on that screen would be in perfect focus over the entire screen with perhaps some residual distortion. Thus, the positive lens has imaged each point in the object to a sharp, in-focus image of that point in the intermediate image. In order to form such a sharp, in-focus point image, the light rays from the positive lens to any point in the intermediate image must be convergent on that point.

Now consider that the light from that focused point in the intermediate image is reflected or scattered back to the positive lens. By the principle of reciprocity, since the lens operates on an object point to form a sharp image point at the intermediate image, the reverse must also be true, within the limits of diffraction. Thus if the intermediate image of a point is sharp and in focus, and if that image is scattered or reflected back into the positive lens, [than] then the light from that image will be re-imaged on the object with similar quality. Note that the distortion and field curvature of the intermediate image are of no consequence because the reflection or scattering from the intermediate image surface has reversed the sign of those aberrations to be exactly cancelled by the lens. It should be noted that this process also applies to lateral chromatic aberration. As long as the image of every color is in focus in the intermediate image, regardless of the relative displacement of those colors in the image, any dispersion by the lens must be exactly cancelled out as the reflected or scattered rays diverging from the image pass back through the lens.

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Please replace the paragraph beginning on column/page 8, line 7 with the following:

In accordance with the present invention, the image source [310] 310' comprises any means of forming a fine scanning spot on the projection screen 312 to form the intermediate image 314, including, but not limited to, a monochromatic or polychromatic scanning laser projector. The projection screen 312 comprises any suitable material or device to scatter the light from the intermediate image 314 into the entrance [aperture] pupil of the re-imaging lens 316. Preferably, such scattering will be confined such that all the light from the intermediate image [310] 314 enters and uniformly fills the entrance [aperture] pupil of the lens 316. Note that such a screen material or device may further comprise a surface which not only scatters the energy from the image source [310] 310' but also which may absorb the light and re-emit it as the intermediate image 314. Note further that if the image source is such that polychromatic light is produced wherein each color can be scanned to form a full-color composite intermediate image 314, then each color component intermediate image should be scanned to pre-aberrate the intermediate image to [accommodate] correct for lateral chromatic aberration in the re-imaging lens 316. Note finally that the [unique combination of] relative independence between the projector beam size and the re-imaging lens [aperture] exit pupil, [and] in combination with the narrow projector beam size, allows the projector to be located off-axis as shown in Fig. 4, providing that the intermediate image formed by the projector is created as an off-axis image. This advantage is made possible by the very long relative depth of focus of the intermediate image.

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Please replace the paragraph beginning on column/page 8, line 41 with the following:

Finally, the present invention is best practiced by employing an aberration reversing means which most closely provides the full properties of phase conjugation as described above. Several reflective and scattering surfaces and structures have been mentioned to at least partially provide such properties. Of particular benefit however, is the use of a concave surface with an additional structure placed thereon. For example, a Fresnel lens structure may be formed on a concave surface. Such a hybrid optical element is particularly useful because while the surface contour can be adjusted to match the field curvature of the intermediate image, the Fresnel structure can be designed to reflect the incident light to concentrate that light into the [aperture of the eye lens] exit pupil. Typically, Fresnel lenses are not employed in high quality imaging systems because of the diffraction and/or gross image artifacts created by the Fresnel structure. However, since the Fresnel structure is located at the image surface in accordance with the present invention, the structure may be made especially fine with relatively little regard for diffraction effects. Further, unlike a conventional light-scattering screen, such a hybrid device may be displaced slightly from the intermediate image without forcing the final image out of focus, providing yet another degree of freedom for the optical designer.